Satellite validation of important ozone-depleting and climate-forcing trace gases from airborne and ground based platforms

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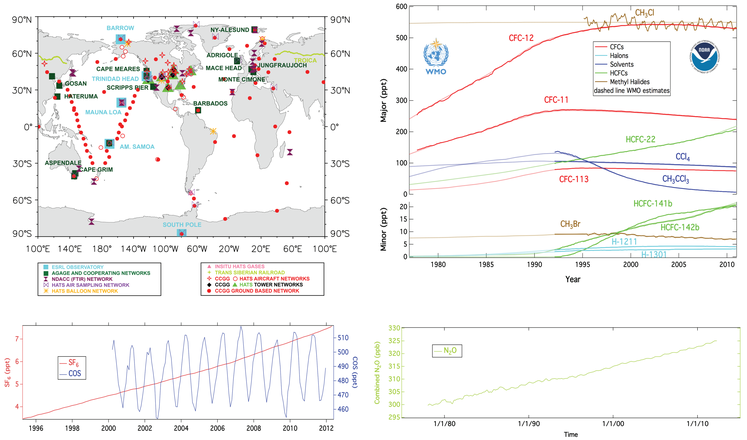
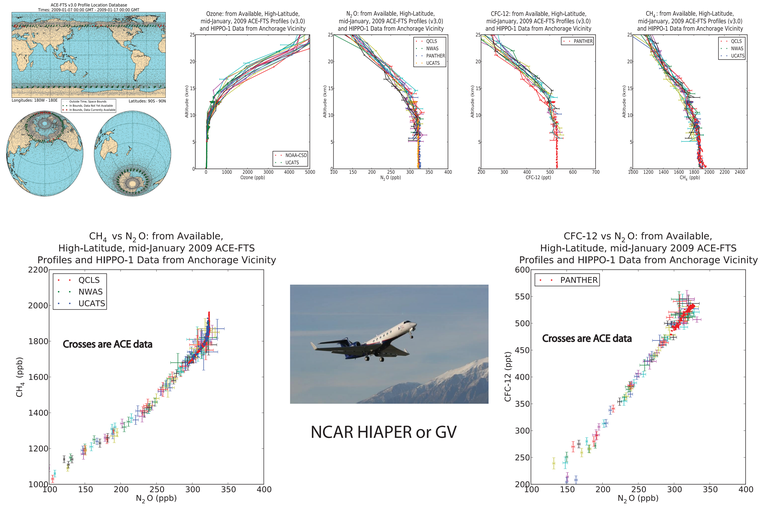
1. Introduction



The Halocarbons and other Atmospheric Trace Species Group (HATS) of NOAA/ESRL/GMD is responsible for measuring non-CO_2 trace gases in the atmosphere. GMD is the WMO Central Calibration Laboratory (CCL) for N_2O, CH_4, CO, SF_6, and CO_2, where many of the gravimetric standards are prepared in HATS. We have an extensive network of flasks, in situ instruments, and airborne platforms shown in the above map. A number of gases including N_2O, SF_6, and select halocarbons are measured in flasks from the Carbon Cycle Greenhouse Gas Group (CCGG, leader: Pieter Tans) network included in the map. Once every 6 months, we meet with scientists from the Advanced Global Atmospheric Gas Experiment (AGAGE, leader: Ron Prinn & Ray Weiss) to compare standards and measurements.

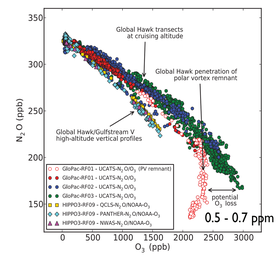
3. HIPPO (GV) vs ACE (FTIR) on SCISAT-1 Satellite

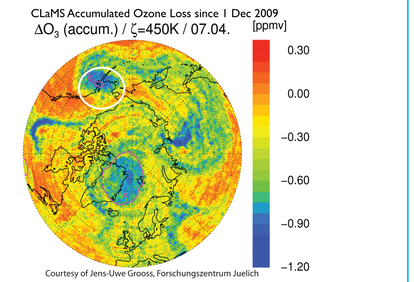


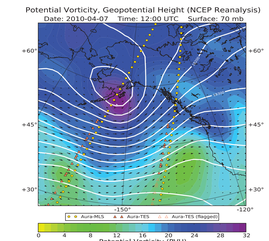
NCAR HIAPER or GV

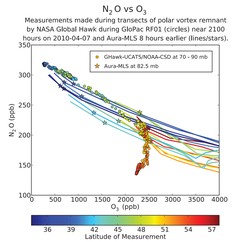
Comparison of the Atmospheric Chemistry Experiment (ACE) on Canada's SCISAT-1 satellite to instruments on board the NCAR GV during HIPPO-1. Map shows where ACE data are used (red). Plots of ACE satellite data and GV aircraft data using UCATS and NOAA-CSD O_3, UCATS, PANTHER, WAS, and QCLS (Harvard) N_2O and CH_4, and PANTHER CFC-12. Tracer-tracer correlations show good agreement for ACE and GV CH_4 vs N_2O and CFC-12 vs N_2O.

5. Observed Ozone Loss during GloPac compared to Aura measurements



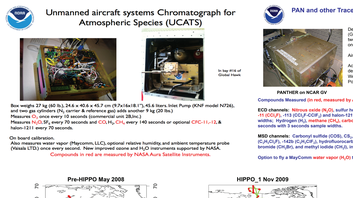


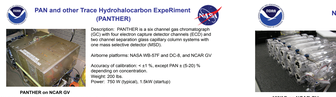




Upper figures show possible ozone loss during GloPac on 2010 April 7. Tracer-tracer correlation of aircraft N_2O versus O_3 show loss of 0.5-0.7 ppm. CLaMs model run of accumulated ozone loss starting 2009 December 1 show similar loss in white circled areas. Back trajectories ran show region is a filament of the polar vortex in January. Using MLS data in region of high PV from the map, the stars (MLS) on the N_2O vs O_3 plot indicate some evidence of the feature observed by the Global Hawk.

2.Airborne Instruments and HIPPO missions used in this presentation





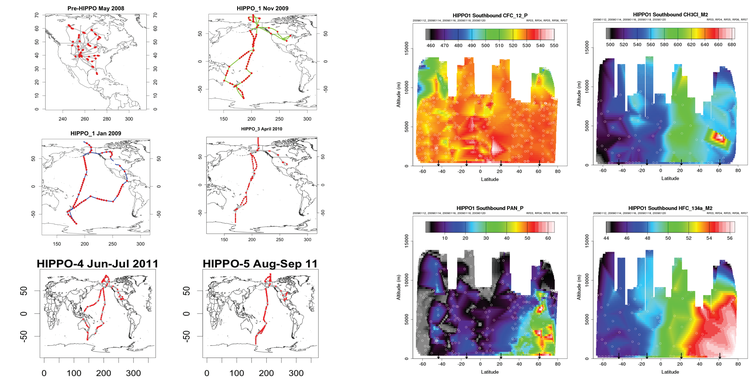
ECD channels: Nitrous oxide (N_2O), sulfur hexafluoride (SF_6), chlorofluorocarbons (CFCs), -12 (CCl_2F_2), -11 (CCl_3F), -113 (CCl_2FCClF_2) and halon-1211($CBrClF_2$) injected every 70 seconds with 3 second sample widths; Hydrogen (H_2), methane (CH_4), carbon monoxide (CO), and peroxyl acetyl nitrate (PAN) every 7-seconds with 3 seconds sample widths.

MSD channels: Carbonyl sulfide (OCS), CBr_2, CFC-13, hydrochlorofluorocarbons HCFC-22 (CHF_2Cl), -141b (CH_3CFCl_2), -142b (CH_3CF_2Cl), hydrofluorocarbons HFC-134a (CH_2FCF_3), methyl bromide (CH_3Br), methyl chloride (CH_3Cl), methyl bromide (CH_2Br), and methyl iodide (CH_3I), injected every 180 seconds with 190 seconds sample width.

Option to fly a MayComm water vapor (H_2O) tunable diode laser spectrometer (TDLS)

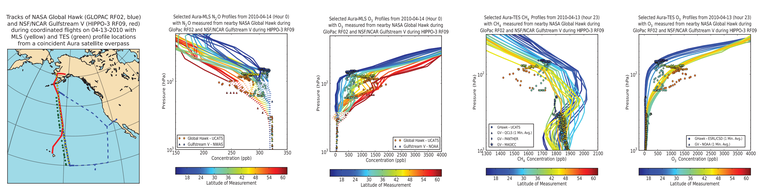
Compounds Measured (in red, measured by Aura):

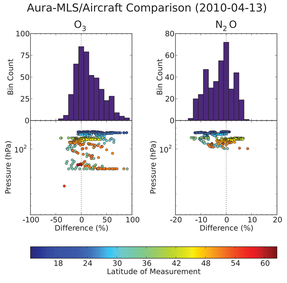
CO, CO_2, CH_4, and CO_2 isotopes, N_2O, SF_6, H_2, tetrachloroethylene (C_2Cl_4), CCl_4, -CFC-11, -CFC-12, -CFC-113, -HCFC-22, -HCFC-141b, -HCFC-142b, -HCFC-143a, -HCFC-152a, -HFC-134a, -HFC-227ea, -HFC-23, -HFC-125, -HFC-134a, -HFC-143a, -HFC-152a, -HFC-245fa(d), halon-1211, halon-1301, halon-2402, chloroform ($CHCl_3$), methyl chloroform (CH_3CCl_3), chloroethane (CH_3CH_2Cl), dichloromethane (CH_2Cl_2), methyl bromide (CH_3Br), dibromomethane (CH_2Br_2), bromoform ($CHBr_3$), diiodomethane (CH_2I_2), methyl iodide (CH_3I), propane (C_3H_8), benzene (C_6H_6), perfluoropropane (PFC-218), iso-pentane (C_5H_{12}), n-butane (C_4H_{10}), n-pentane (C_5H_{12}), n-hexane (C_6H_{14}), carbonyl sulfide (OCS), and carbon disulfide (CS_2).



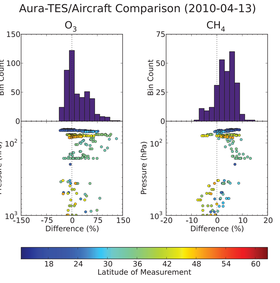
NOAA HATS instruments on HIaper Pole-to-Pole Observations of Greenhouse Gas (HIPPO) with NCAR's GV aircraft. UCATS also operated on Global Hawk Pacific (GloPac). Cross sections shown from HIPPO-1.

4. HIPPO (GV) and GloPac (Global Hawk) aircraft comparsions versus Aura MLS & TES



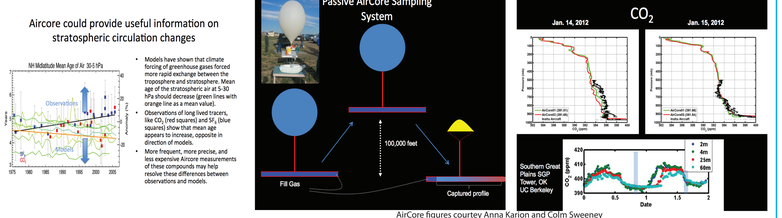


NASA Global Hawk



Comparsion of airborne instruments from the overflight of Global Hawk (dashed blue line on map) over GV (red line) versus Aura MLS and TES on 2010 April 13. N_2O and CH_4 compare well (better than 5%), while Aura O_3 is almost +16 % higher than aircraft measurements.

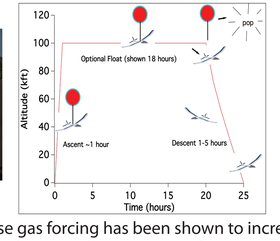
6. Future Work

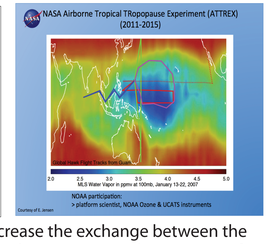


NOAA SkyWisp UAS Configuration

- Glider plus payload (3)
- Ground Station (2)
  - GlideTerm Software
  - Trackable Antenna System
  - Glider Comms System
  - Manual RC System
- Launching System
- Launching Supplies

Fred Moore, Co-I, with SkyWisp





Climate change from greenhouse gas forcing has been shown to increase the exchange between the troposphere and stratosphere or decrease the mean age of air at 5-30 hPa. However observations of mean age from observations of SF_6 and CO_2 show an increase. We propose a low cost monitoring program using the same principals of the Aircore developed by Pieter Tans' group that found good agreement between aircraft and Aircore measurments of CO_2. NOAA has funded our development of a StratCore, a smaller stratospheric version, using a small NOAA UAS. We are hoping to prove that a balloon launched StratCore will allow us to get trends of age and trace gases. We also are participating on the Airborne Tropical TRopopause EXperiment (ATTREX) to study water and trace gas exchange.